
Update and revision of Turkish air quality regulation

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Abstract: The Air Quality Assurance Regulation (AQAR) was issued on October 1986. This regulation was basically a direct translation of the German TA-Luft of 1984. The main purpose of AQAR was to control the effect of industry, domestic heating and Traffic on ambient air quality which previously had not adequately been represented. Two new regulations, “Industry Related Air Pollution Control Regulation” (IRAPCR) and “Heating Related Air Pollution Control Regulation” (HRAPCR), came into force in 2004 and 2005, respectively. Two more regulations on traffic-related air pollution control and ambient air quality are to be issued. In this study, we evaluate the two air pollution control regulations IRAPCR and HRAPCR on legal, technical, administrative, practical and global basis. A comparison of these two new regulations with EU Directives has also been made.

Keywords: air quality; regulation; emission limits; industrial pollution; heating.

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1 Introduction

In a previous paper we reported a fundamental weakness of the Turkish Air Quality Assurance Regulation (AQAR): its misapplication to the actual conditions in the country (Okutan et al., 1997). A contradiction between the characteristics of the fuels produced and emissions limits imposed to these fuels, and classification of the industrial sectors not reflecting the structure of the industry, are given as two examples. The reason given for the weakness of the Regulation was the fact that it was mostly a translation from German regulation in 1986 (Official Gazette, 1986). AQAR was issued as a continued environmental legal structuring in Turkey based on the 1982 Constitution and the Environment Law of 1983. AQAR generally deals with ambient air quality, industrial installations, and the utilisation of fuels for heating. The restrictions on the ambient air-quality limiting values are imposed differently for general, heavy industrial and special conserved areas on long and short term bases. On the other hand, bases for target limiting values, clean air plans and modelling are established. The industrial installations are categorised in three groups: High-Polluting Installations (HPI); Installations Subject To Permit (ISP); and Installations Not Subject To Permit (INSP) The fuel utilisation for heating purposes is given under ‘combustion installations’ title and in high polluting installations and installation subject to permit categories. Vehicles are not dealt with in AQAR.

AQAR had limited success in the establishment of sound air-quality assurance in the country due to many reasons: lack of implementation structure and resources; inadequate fuel supply to the country; contradictions between authority and responsibility;

slow response in the bureaucratic structure; failure to include representatives of industrial stakeholders; regulation falling behind the fast developments in some industrial sectors; and inspection and economic deficiencies. However, it should be noted here that acute air pollution problems experienced in some of the populated cities in Turkey were resolved to a significant degree thanks to utilisation control of the quality of fuel. Due to the massive harmonisation efforts of the legal system with the EU, new regulations are being issued to replace the AQAR. The Industry Related Air Pollution Control Regulation (IRAPCR) (Official Gazette, 2004) and Heating Related Air Pollution Control Regulation (HRAPCR) (Official Gazette, 2005) were issued 7 July 2004 and 13 January 2005, respectively. And two more regulations, on ambient air quality assurance and control of vehicle emissions, are also being prepared. Regarding air quality, preparation of "The Air Framework Draft Law" is planned for the harmonisation with EU Directive (2001/80/EC), concerning large combustion installations and "Air Quality Framework Directive". There are ongoing preparations for "Large Heating Installations" (LHI) which have thermal power output higher than 50 MW, and for the creation of 'emissions trading'. Completion of all these preparations will meet most of the harmonisation program of Turkish Air Quality System with the EU.

2 Comparison of industry related air pollution control regulation and air quality assurance regulation

AQAR consists of eight sections, 64 papers, one temporary paper and ten additional appendices. The Prime Ministry's General Directory and Ministry of Health were the primary responsible authority and Ministry of Energy and Natural Resources, Ministry of Industry and Trade and Municipalities are the other related institutions.

As explained above, the installations were grouped into ISP, INSP and HPI according to AQAR. Furthermore, ISP had ten main groups and 136 subgroups and HPI had 18 main groups and 43 subgroups.

The weakness of AQAR in many areas is attributed to the fact that it was not based on facts and information on the sources of polluting sources. Even today there is not a sound emission inventory in various sectors. The only complete emission factors for conventional and micro pollutants which has been realised is for the cement production plant, by the Quality and Environmental Council (Ekinici et al., 1998; Canpolat et al., 2002). During the course of application of AQAR, sharing control of the emission permit procedure by the municipalities and the mayor's offices weakened the overall controlling operation and prevented the accumulation of emission information in one common pool. For this reason, even after 18 years a healthy emission inventory could not be established. The public and private emission measuring institutions did not use common and internationally accepted standards and equipment, and this shortcoming makes it difficult to have confidence in the accuracy of the comparable measurements after 18 years of AQAR application. Clean air plans could not be realised. The legal limits on the ambient air quality were kept at higher levels than is the case in the EU and some other countries. The renewable energy resources were not included into the provisions of AQAR. The liquid fuels produced at the refineries had sulfur contents which had no relevance to the limits imposed on SO₂ emissions.

Installations classified under HPI and ISP did not represent the state of the industrial structure in the country and caused problems in application. The limiting excess oxygen

for the case of inefficient and variable small scale and mostly heating installations had 13% excess oxygen limitations. On the other hand, for gas turbines operating under high excess air rates of 13–15% were restricted to 3% excess oxygen. For the ‘old aged’ installations having an operation life of less than 20,000 hours, the limit values were diluted and thus caused serious confusion in application. The dust emission limitation for the combustion appliances were kept high due to insufficient control technologies and resources of the country. In the chimney control issues, like flue gas discharge velocity and chimney height, there have been difficulties in application. Even though stone and sand quarries were sources of high dust emissions, the controlling capability of the AQAR was very limited.

One of the main new concepts ushered in by the new IRAPCR relates to the level of technology used in installations. Clean technologies are accepted as the priority goal. For this purpose it is accepted that for the plants in continuous operation and which have realised a successful consolidation and control (due to comparable methods, setups and operational modes), the emission limitation precautions become practical and usable, advanced and suitable to the national conditions and cleaning methods which constitute the essence of ‘technological level’ and which comprise the foundation of the Regulation. This level dictates which waste free or minimum waste and clean production technologies should be considered before the treatment option.

In the new IRAPCR, ISP and HPI classifications of the industries the number of sections increased and new industries were introduced. For example, under the ISP heading ten main groups and 138 subgroups were defined, whereas for HPI 26 main groups and 61 subgroups were defined. In particular the combustion installation which was referred as Group I in HPI is branched into eight subgroups. The extensive use of internal combustion engines in co-generation and combined cycle installations, given as diesel engines and gas engines and gas turbines, are also included as new combustion installations. In this group, apart from the known fuels, petroleum coke and biomass are included as well. And others also became subject to regulation for the first time: cote, barn, slaughterhouses, and fat melting related to recovery of wastes from these operations, meat smoking, animal dung drying, plant protection and pesticide production plants, metal painting, automobile and house appliance painting, storage of petroleum and liquid fuels, yeast production, vegetable oil production and sugar and sugar molasses drying plants. This approach is generally in accordance with the structure of industry at present day Turkey. In the new Regulation, the ‘old plant’ concept has been dismissed altogether.

IRAPCR also introduces for the first time an ‘efficiency concept’ in AQAR. According to this new provision, if a plant is operated at a higher efficiency than the set value, the restrictions are then calculated by multiplying with a correction factor calculated as: efficiency realised/efficiency set. Accordingly the emission limits of efficiency combustion plants may be increased, which will in the long run prevent the operation of low efficiency combustion plants.

2.1 Comparison of IRAPCR and AQAR in terms of emission restrictions

For the case of ISP, the emission limits for dust, Special Dusts (SD), organic gases and vapours, Carcinogenic Substances (CS), flue gas velocities, chimney height and excessively dangerous substances for both regulations are compiled in Table 1. The changes are indicated in bold characters.

Table 1 Emission limits for IRAPCR and AQAR

<i>Emission parameters</i>		<i>AQAR</i>	<i>IRAPCR</i>
Soot	Solid fuel	<2 Ringelman scale	≤3 Ringelman scale
	Liquid fuel, Diesel oil	<2 Bacharach scale	≤2 Bacharach scale
	Liquid fuel, Fuel oil number 4 and 5	<3 Bacharach scale	≤3 Bacharach scale
	Liquid fuel, Fuel oil number 6	<4 Bacharach scale	–
Dust (Diagram 1)	Chimneys	Max. 500 mg/m ³	Max. 325 mg/m ³
	Loading, Handling etc.	<3 kg/h 300 mg/m ³	<1.5 kg/h 200 mg/m ³
	Loading, Handling etc.	>3 kg/h 150 mg/m ³	1.5 < total dust < 2.5 150 mg/m ³
	Loading, Handling etc.	–	>2.5 kg/h 100 mg/m ³
Special dusts		Same	Same
Organic gases and vapours		Same	Same
Carcinogenic substances		Same	Same
Flue gas velocities	TP > 300 kW	>6 m/s	
	TP < 300 kW		≤2 m/s
	200 < TP < 500 kW		≥2 m/s
	TP > 500 kW		velocity ≥4 m/s (compulsory conditions, may be ≥ 3 m/s)
Chimney height	TP < 300 kW	1m above the roof	
	300 kW < TP < 1 MW	1m above the roof	
	TP > 1.2 MW	At least 19 m from the ground and 3 m above the roof	At least 10 m from the ground and 3 m above the roof
	TP < 500 kW		1 m above the roof
	500 kW < TP < 1 MW		2 m above the roof
Exceedingly hazardous substances*	PCB, PCDD, PCDF	–	<0.01 ng/Nm ³

*Instead of the 0.01 ng/Nm³ limit value cited in the regulation 0.1 ng/Nm³ value is being used.

The changes in Table 1 show that in soot control similar limits are imposed to the other fuels and the dust emission limitations are based on the load and concentration. An important change has been made on the flue gas velocities and chimney heights which had substantial application difficulties under AQAR.

2.2 Monitoring of the ambient air quality at the impact area of the installations

In the new approach for the installations having emissions above a defined value, the effect of emissions on the surrounding air quality does not need to be determined by direct measurements. The polluting substances discharged from chimneys and the other ways are reported as the mass flowrate. The related values to the mass flowrates are given in Appendix 3 in AQAR and in paper 40 and Table 14-1 in IRAPCR. The differences between the two regulations are listed in Table 2.

Table 2 The emission value changes made in the two regulations for installations' contributions to air pollution

Emitted hazardous substances	The mass flowrates under normal working conditions and working days (kg/hr)			
	AQAR		IRAPCR	
	From chimney	From other sources	From chimney	From other sources
Hydrogen fluoride and gaseous inorganic fluoride compounds	1	0.1	2	0.2
Hydrogen sulphide	–	–	4	0.4
Carbon monoxide	1000	100	500	50
Total volatile organic compounds	–	–	30	3

For the ambient air quality measurement around the plant for the gaseous and dust pollutants, the period was specified as not less than six months in AQAR, but this period is specified as one month for at least two stations. A passive sampling system is accepted, and for this purpose the measurement period is determined as two months for a measurement points of at least eighteen places. For the settling dust measurements, a period of two months from two stations is required.

Evaluation of the changes between the two regulations from Table 2 show that hydrogen sulphide and total volatile substances are included in IRAPCR and the carbon monoxide and fluoride compounds limit values are reduced by 50% and 100 %.

2.3 Continuous measurements

The changes in the continuous measurement of emissions in large plants are given in Table 3, which compares Appendix 2 of AQAR, and paper 41 of IRAPCR.

Table 3 Comparison of the continues emissions required by the two regulations

<i>Pollutant</i>	<i>Fuel type</i>	<i>AQAR</i>	<i>IRAPCR</i>	<i>Parameter to be measured</i>
		<i>Capacity</i>	<i>Capacity</i>	
Combustion control (combustion installation)	Solid and liquid	TP*>15 GJ/h (4.167MW)	36 GJ/h (10 MW)	CO ₂ or O ₂ and CO
Sulphur dioxide		100 kg/h	60 kg/h	SO ₂
Carbon monoxide (for other installations)			50 kg/h	CO

From the table it is clear that, for the purpose of combustion control, the continuous monitoring limit of the plants was increased from 4.167 MW to 10 MW for carbon dioxide or oxygen and carbon dioxide, and the mass emission of sulphur dioxide is reduced to 60 kg/h. Carbon monoxide emission limitations are imposed for other installations for the first time, due to the issuing of IRAPCR.

The POP's group parameters are reduced, under the title of "excessive hazardous substances" in IRAPCR, for the first time.

In AQAR, the oxygen ratio in the flue gas for the small capacity heating solid fuel installations, which are usually inefficient and fluctuating, are set at very high value of 13%. On the other hand, the gas turbines which on technological reasons operate at high oxygen ratios of 13–15% were given a limiting value of 3%, which caused considerable problems in the past years.

In IRAPCR, for the solid burning installations the oxygen excess ratio is set as 6% and for internal combustion engines and for gas turbines it is set as 15%. The petroleum coke and biofuels are included in the air quality regulations for the first time. The dust emissions limit values are reduced and for the liquid fuels sulphur dioxide limiting values are increased considering the refinery capacities in the country up to 100 MW capacity. For the installations having thermal capacities up to 100 MW using liquid or multiple fuels, provided that one of the fuels is liquid and taking 3% excess oxygen as the base the sulphur dioxide limit was increased from 1700 mg/Nm³ to 2400 mg/Nm³. For the liquid fired combustion installations for 1.5% sulphur content fuels in a similar manner sulphur dioxide limit has been increased to 2400 mg/Nm³ and in case of unavailability of the proper fuel provided that it does not exceed six months the limit can be 3000 mg/Nm³. By this way provided that the emissions are monitored by continuous measurement at the transient stage fuel oil and gaseous fuels may be burnt together.

2.4 Emission of specific pollutants

According to AQAR the specific pollutants are classified as SD, Organic Gas and Vapours (OGV) and CS. In the SD list (Appendix 3) 49 inorganic substances, in the OGV list (Appendix 4) 121 organic compounds, and in the CS list (Appendix 5) 15 special substances are included. These substances are sub divided in to three different classes and for each of them different volumetric and mass emission limits are listed.

In IRAPCR, SD is listed as Table 39.1, OGV as Table 39.2 and CS as Table 39.3 but there is no change in the number of pollutants and in the emission limitations. However, it is planned to bring reductions in the emission limits starting from 1.1.2007. The changes related to these polluters are given in Appendix 3 for SD group under three

new groups in IRAPCR. These are Special Substances in Inorganic Dust Emissions (SSIDE), Table 1.1 containing a list of 21 Inorganic Vapour and Gases (IVG) containing a list of 29 pollutants totalling 96 pollutants.

238 OVG substances are listed in Table 1.2. The volumetric and mass based emission limits for these kind of polluters are reduced at an appreciable level. In order to provide the necessary backup and planning the facilities in the laboratories to improved in order to be able to perform the necessary detailed analysis required by the new Regulation. This of course need to be backed up with substantial financial backing and intense accreditation efforts of the laboratories.

2.5 Measurement frequency

In air quality control policies usually it is desired that the emission measurements should be done as frequently as possible. However this approach may cause the increase of the measurement needs to excessive levels which may result in a drop in the quality of services and raise queries on the dependability of the services. In AQAR in the emission permits measurements were necessary for every year (Paper 36) or once every two years (Paper 22). Whereas in IRAPCR the measurement frequency (Paper 15) is widened for the plants in List A'da as two years and for the plantas listed in List B as three years.

3 Heating Related Air Pollution Control Regulation (HRAPCR) and emission restrictions

HRAPCR consists of 35 papers and ten Appendices. In the majority of the residential regions the most dominant air pollution source during the past ten years or so has been the fuel used for heating. For this reason both the combustion appliances and stadardisation of the has to be considered for proper polution manegement. IRAPCR generally prepared with this view and therefore favours the use of natural gas for heating purposes. The combustion installations starting with TP < 15 kW are to be evaluated according to Turkish Standarts TS and EC norms to standardise them in terms of technological level and efficiency. The principal intention was to reduce the harmful effect of combustion of different quality fuels in a variety of combustors.

Fuels are defined in Paper 5 as follows.

(a) Coal

- Bituminous coal, bituminous coal briquettes, bituminous coal coke
- Lignite, lignite briquette
- Peat briquette, peat
- Anthracite
- Asfaltite.

(b) Wood, wood derived fuels and other biomass fuels

In this section wood and wood derived fuels are defined in seven categories.

(c) Liquid fuels

Imported fuel oil with a maximum sulfur content of 1.0% and indigenous fuel oil with maximum sulfur content 1.5% and after 1/1/2007 indigenous fuel oil with maximum sulfur content of 1% also diesel gasoline, kerosene ethanol and similar fuels.

(d) Gaseous fuels

City gas, natural gas, Liquefied Petroleum Gas (LPG), hydrogen, biogas, treatment gas, coke oven gas, coal bed methane, blast furnace gas, refinery gas and synthetic gas are in this list. The sulphur content of the gaseous fuels is limited to 0.1%.

3.1 Forbidden substances

Those substances not referred to in (a), (b), (c) and (d) of this section are forbidden to be burnt for heating purposes. They include: petroleum coke, used mineral oil, pieces of vehicle tyre, dung, solid wastes and textile wastes, cables, wet wood, painted wood, plastics, household goods excluding newspapers and food wastes and other household wastes, special wastes, medical wastes, asphalt and asphalt products, paint and paint products and fuel-oil containers.

The restrictions related to the fuels defined above are given in Table 4.

Table 4 Heating Related Air Pollution Control Regulation (HRAPCR)

CI	Thermal power (TP) (kW)	Fuel types	O ₂ (%)	Soot	Emission limitations (mg/Nm ³)				Heat loss with flue gas (%)
					Dust (mg/Nm ³)	CO (mg/Nm ³)	NOx (mg/kWh)	HC (as CH ₄) (ppm)	
SF	TP ≤ 15	Coal wood	13	<1RS	150				
SF	15 < TP < 1000	Coal wood	8	<1RS	150				
SF	15 < TP ≤ 50	Wood	13	1RS	150	4000			
SF	50 < TP ≤ 150	Wood	13	1RS	150	2000			
SF	150 < TP < 500	Wood	13	1RS	150	1000			
SF	500 < TP ≤ 1000	Wood	13	1RS	150	500			
SF	15–1000	Wood	13	1RS	150	4000			
SF	15 < TP ≤ 100	Wood	13	1RS	150	800			
SF	100 < TP ≤ 500	Wood	13	1RS	150	500			
SF	500 < TP ≤ 1000	Wood	13	1RS	150	300			
L&GS		Fuel oil					250		
L&GS	TP < 120	Diesel oil					120		
L&GS	TP < 120	Natural gas					80		
PBLFCI	70 < TP ≤ 1000	Liquid fuel				110 mg/kWh	250	20	11
PBLFCI	15 < TP ≤ 70 (1. class)*	Liquid fuel		1RS	2-4 BS	110 mg/kWh	185	10	11

Table 4 Heating Related Air Pollution Control Regulation (HRAPCR) (continued)

CI	Thermal power (TP) (kW)	Fuel types	O ₂ (%)	Soot	Emission limitations (mg/Nm ³)				Heat loss with flue gas (%)
					Dust (mg/Nm ³)	CO (mg/Nm ³)	NO _x (mg/kWh)	HC (as CH ₄) (ppm)	
PBLFCI	15 < TP ≤ 70 (2. class)*	Liquid fuel		1RS	70–150	80 mg/kWh	120	10	11
PBLFCI	15 < TP ≤ 70 (3. class)*	Liquid fuel		1RS		60 mg/kWh	120	10	11
GFCI	70 < TP ≤ 1000	Gas fuel		1	–	1070	260	20	9
GFCI	30 < TP ≤ 70 (1. class)*	Gas fuel		1	–	–	260	20	9
GFCI	30 < TP ≤ 70 (2. class)*	Gas fuel		1	–	–	200	20	9
GFCI	30 < TP ≤ 70 (3. class)*	Gas fuel		1	–	–	150	20	9
GFCI	30 < TP ≤ 70 (4. class)*	Gas fuel		1	–	–	100	20	9

CI: Combustion Installations; SF: Solid Fuel; L&GS: Liquid and Gas Oil;

PBLFCI: Pulverised Boiler-Liquid Fuel Combustion Installations; PB: Pulverised Boiler;

GFCI: Gas Fuel Combustion Installation.

In Table 4, no limits have been imposed on the SO₂ pollutant. This control is achieved by the control of fuel specifications. In actual practice, depending on the frequency of exceeding the air quality limit, the values specification of the fuels are announced by the authorities. In the provinces where the limiting values are exceeded the maximum sulphur content of the fuel is 2%, whereas in provinces where the limit values are not exceeded the sulphur content limit is 2.3%. Similarly the 20% ash limit is also increased.

On the other hand, the limits imposed on the coal supply by the new regulation resulted in shortages for both national and imported coal supplies. Therefore a circular has been issued to solve the problem which has arisen from the application of HRAPCR on 26/05/2005, in which the limits are loosened especially as moisture and ash limit values are increased (Table 5).

Table 5 Properties of the fuels used for heating

Coal name	Properties	Limitations-regulation	Limitations-circular
The properties of the coal that will be used in cities and towns where the air quality limitations are exceeded	Total sulphur (on dry basis)	2% (max.)	
	Lower calorific value (original)	4000 (–200 tolerated) Kcal/kg (min.)	
	Total moisture (original)	20% (max.)	max. 25%
	Ash (on dry basis)	18% (max.)	max. 25%
	Swelling index	1 (max.)	
	Dimension*	18–150 mm (Until 18 mm max. 10% is tolerated, above 150 mm max. 10% is tolerated)	

Table 5 Properties of the fuels used for heating (continued)

<i>Coal name</i>	<i>Properties</i>	<i>Limitations-regulation</i>	<i>Limitations-circular</i>
The properties of the coal that will be used in cities and towns where the air quality limitations are not exceeded	Total sulphur (on dry basis)	2,3% (max.)	
	Lower calorific value (original)	3500 (–200 tolerated) Kcal/kg (min.)	
	Total moisture (original)	20% (max.)	max. 30%
	Ash (on dry basis)	20% (max.)	max. 30%
	Swelling index	1 (max.)	
The properties of the coals used in the residence areas outside of the cities and towns which are pollution rated (villages etc.)	Dimension*	18–150 mm (Until 18 mm max. 10% is tolerated, above 150 mm max. 10% is tolerated)	
	Total sulphur (on dry basis)	–	max. 2,5%:
	Lower calorific value (original)	–	Min 3000 kcal/kg (–200 tolerated):
The properties of the coals imported for heating use	Dimension*	–	18–150 mm (Until 18 mm max. 10% is tolerated, above 150 mm max. 10% is tolerated)
	Total sulphur (on dry basis)	0.9% (max.)	
	Lower calorific value (original)	6200 kcal/kg (min.)	min 6200 kcal/kg (–400 tolerated)
	Volatile matter (on dry basis)	12–28% (+1 tolerated)	
	Total moisture (original)	% 10 (max.)	
	Ash (on dry basis)	14% (max.) (+1 tolerated)	
	Swelling Index	1 (max.)	
The properties of the coals imported for industrial use	Dimension*	18–150 mm (Until 18 mm max. 10% is tolerated, above 150 mm max. 10% is tolerated)	
	Lower calorific value (original)	–	min 6000 kcal/kg (–500 kcal/kg tolerated)
	Total sulphur (on dry basis)	–	max. 1%
	Volatile matter (on dry basis)	–	max. 36%
	Dimension*	–	0–50 mm

*marketed in standard bags.

HRAPCR introduced a swelling index concept, which is a measure of cokability and fast volatile release. The swelling behaviour of Turkish coals is not well documented, and this shortcoming may cause further bottlenecks and other possible problems in the future. Efforts to increase coal quality prior to use could not be strengthened. The practical results of the applications will be obtained during the winter of 2005–2006.

4 Conclusion

In this paper comparison of the AQAR of 1986 and replacing two regulations IRAPCR and HRAPCR is made. Evaluation of two new regulations especially in view of the failures of the former is also offered. AQAR was useful in producing a management concept and discipline to Turkey, and as well as by crystallising the missing points and national realities. Together with the other two regulations that are in the preparation stage, a set of four regulations are expected to provide harmonisation of Turkish air quality assurance system with EU regulations. Past experience should demonstrate that these regulations can only serve their purpose efficiently if they are sufficiently dynamic to respond to the changes in the country and in the world. Corrective developments after the issuing of HRAPCR of the coal characteristics for heating purposes, may be interpreted to mean that the new concept will be more responsive to needs and problems. This on the other hand points to weakness to the new regulations in that they are not based on relevant data. Furthermore there are also impertinent sections, and these may be direct translations, as in the case of the “Wood, Wood Derived Fuels and Other Biomass Fuels” section of HRAPCR. For the purposes of implementation, the regulations must be supported with research, data collection, allocating resources, and technical and service back-ups.

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